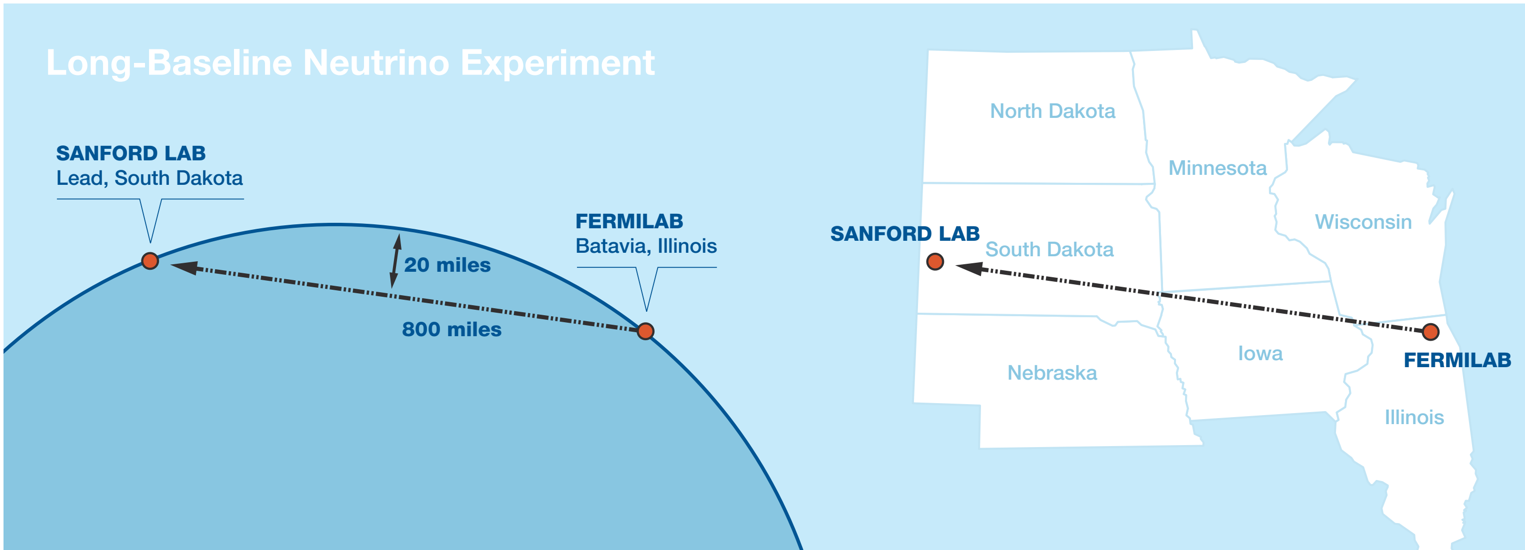
Long-Baseline Neutrino Experiment (LBNE)

A new particle physics experiment, planned to take place at Fermilab and the Sanford Lab, aims to transform our understanding of neutrinos and their role in the universe.



The proposed Long-Baseline Neutrino Experiment would send neutrinos straight through the earth from Batavia, Illinois, to Lead, South Dakota. No tunnel would be necessary for this 800-mile-long trip.

Mysterious neutrinos

Neutrinos are among the most abundant particles in the universe, a billion times more abundant than the particles that make up stars, planets and people. Each second, a trillion neutrinos from the sun and other celestial objects pass through your body. Although neutrinos are all around us, they interact so rarely with other matter that they are very difficult to observe.

The latest developments in particle accelerator and detector technology make possible promising new experiments in neutrino science. A collaboration of more than 450 scientists from six countries has proposed to build a world-leading neutrino experiment that would involve construction at both Fermi National Accelerator Laboratory (Fermilab), located in Batavia, Illinois, and the Sanford Underground Research Facility (Sanford Lab) in Lead, South Dakota.

Why are neutrinos important?

Neutrinos may provide the key to answering some of the most fundamental questions about the nature of our universe. The discovery that neutrinos have mass, contrary to what was previously thought, has revolutionized our understanding of neutrinos in the last two decades while raising new questions about matter, energy, space and time. Neutrinos may play a key role in solving the mystery of how the universe came to consist of matter rather than antimatter. They could also unveil new, exotic physical processes that have so far been beyond our reach.

Facts about neutrinos

Neutrinos are elementary particles that have no electric charge. They are among the most abundant particles in the universe.

They are very light. A neutrino weighs at least a million times less than an electron, but the precise mass is still unknown.

In nature, they are produced in great quantities in the sun and in smaller quantities in the Earth. In the laboratory, scientists can make neutrino beams with particle accelerators.

Neutrinos pass harmlessly right through matter, and only very rarely do they collide with other matter particles.

There are three types of neutrinos: electron neutrinos, muon neutrinos and tau neutrinos.

The laws of quantum mechanics allow a neutrino of one type to turn into another one as the neutrino travels long distances. And they can transform again and again. This process is called neutrino oscillation.

Understanding neutrino oscillations is the key to understanding neutrinos and their role in the universe.

The distance between Fermilab and the Sanford Lab is 800 miles. It is ideal for measuring neutrino oscillations with the proposed Long-Baseline Neutrino Experiment.

A national laboratory funded by the Office of Science of the Department of Energy.

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U.S. DEPARTMENT OF ENERGY Fermilab Sanford Underground Research Facility

Long-Baseline Neutrino Experiment (LBNE)

What is LBNE?

The proposed Long-Baseline Neutrino Experiment would use Fermilab's particle accelerators to create neutrinos and send them through the earth to a new, large, cutting-edge neutrino detector at the Sanford Lab. The neutrinos would travel the 800 miles from Illinois to South Dakota straight through the earth—no tunnel is needed for these particles.

The LBNE particle detector at Sanford Lab would record neutrinos and measure their oscillation properties. With the data, scientists aim to discover whether neutrinos and antineutrinos interact differently with matter. They would also be able to determine which type of neutrino is the lightest and which is the heaviest. This information would help reveal the exact role that neutrinos play in the universe.

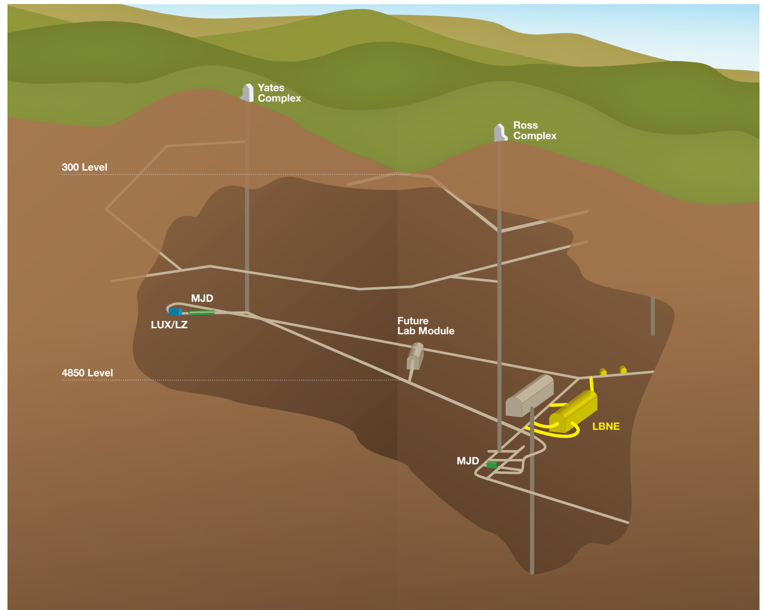
How does LBNE work?

Scientists can make neutrinos with particle accelerators. At Fermilab, scientists have operated neutrino-producing facilities for more than 30 years.

For the LBNE project, scientists plan to construct a new beamline to send neutrinos from Fermilab to the Sanford Lab in South Dakota. It would steer protons from Fermilab's Main Injector accelerator up a small hill (see graphic below) and then point the beam into the ground, toward the Sanford Lab. The protons would smash into a piece of graphite. The particles that emerge from these collisions would go into a 680-foot-long tunnel and generate neutrinos that travel in the same direction as the protons. With support and resources from additional partners, scientists would also build a state-of-the-art underground hall with a particle detector that would measure the composition of the neutrino beam as it leaves the Fermilab site.

Traveling at close to the speed of light, the neutrinos would leave the Fermilab site at a depth of about 200 feet, continue straight through the earth and arrive at the Sanford Lab in South Dakota within a fraction of a second. Because neutrinos can travel through matter, no tunnel would be necessary for this 800-mile trip.

At the Sanford Lab, a large particle detector would record the arrival of the neutrinos by measuring the rare interactions of neutrinos with the detector. It would transmit the data to computers for storage and analysis. Once the experiment is operational, it would take about a decade to collect enough data to make the hoped-for discoveries that would revolutionize our understanding of the universe.



With support and resources from additional partners, scientists would build the LBNE particle detector deep underground, in a new cavern to be excavated on the 4850-foot-level of the Sanford Lab. This deep location would shield the detector more from cosmic rays.

More information

LBNE website:
lbne.fnal.gov

Fermilab website:
www.fnal.gov

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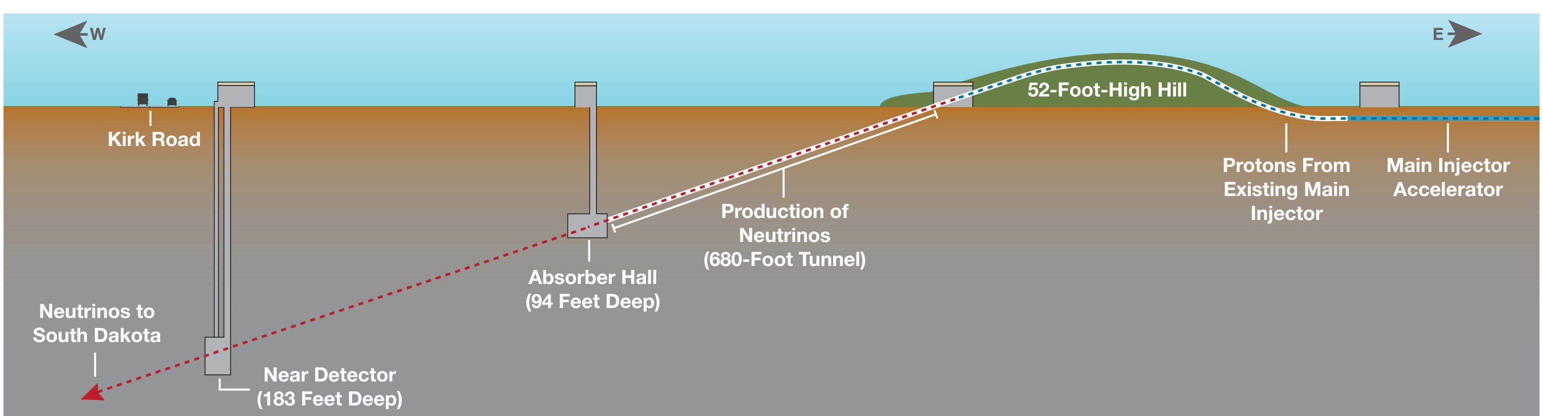

Fermilab plans to use its Main Injector accelerator to make neutrinos and send them through the earth to the LBNE particle detector in South Dakota. The project proposes the construction of four buildings, a 52-foot-high hill made of compacted soil and a 680-foot-long tunnel on the Fermilab site.